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Reducing Morbidity in Urgent Gastroenterologic Surgery; Propensity Score Analysis Using Triclosan-Coated Polydioxanone Sutures

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Superficial surgical site infections (S-SSIs), which prolonged hospital stay and increased costs, are a critical problem. The aim of the present study was to clarify the risk factors for S-SSIs after urgent gastroenterologic surgery and what surgeons can do to reduce their incidence and to shorten the hospital stay. A total of 275 patients who underwent urgent gastroenterologic surgery were enrolled in the present study. The correlations between the incidence of S-SSIs and clinicopathologic factors were retrospectively analyzed using propensity score matching. Of 275 cases, 43 (15.6%) patients had an S-SSI. On univariate analysis, the following factors were associated with a significantly higher incidence of S-SSI: American Society of Anesthesiologists score ($P = 0.043$); wound classification ($P = 0.0005$); peritonitis ($P = 0.019$); prolonged operation time ($P = 0.0001$); increased blood loss ($P = 0.019$); transfusion ($P = 0.0047$); and abdominal closure without triclosan-coated polydioxanone sutures ($P = 0.042$). However, a propensity score–matching analysis showed that abdominal closure using triclosan-coated polydioxanone sutures did not reduce the incidence of S-SSIs in patients who underwent urgent gastroenterologic surgery ($P = 0.20$), but it tended to be associated with a shorter hospital stay ($P = 0.082$). To reduce morbidity after urgent gastroenterologic surgery, surgeons should shorten the operation time and decrease the blood loss. In addition, abdominal closure using triclosan-coated polydioxanone

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sutures alone could not reduce the incidence of S-SSIs but might shorten the hospital stay after urgent gastroenterologic surgery by inhibiting bacterial activity and preventing prolongation of the infections.

Key words: S-SSIs – Urgent gastroenterologic surgery – PDS Plus – Propensity score

The prevention of surgical site infections (SSIs) is an important task because of the mental and physical burdens on the patient associated with their development. Furthermore, a prolonged hospital stay and the increased costs associated with treatment constitute an economic burden for patients.[1–3] To date, many studies have been performed to examine the risk factors for SSIs, including wound classification; the American Society of Anesthesiologists (ASA) score; and the level of blood loss or the performance of blood transfusion, with a hope of reducing the incidence of SSIs.[4–7] Although most of the above risk factors are dependent on the patient's condition, it has been reported that abdominal closure using triclosan-coated polydioxanone sutures (PDS Plus, Ethicon, Somerville, New Jersey) might be a measure that surgeons can implement to reduce the incidence of SSIs; however, the efficacy of PDS Plus remains controversial in this regard.[7–10] The authors also demonstrated the efficacy of PDS Plus in the prevention of superficial SSIs (S-SSIs) in a recent study.[11] Recently, the efficacy of antimicrobial-coated sutures has been published in new World Health Organization guidelines on the prevention of surgical site infection as conditional recommendation, moderately quality of evidence.[12]

The risk of SSIs after urgent gastroenterologic surgery inevitably increases because the patients' condition is characterized by a poorer wound classification or a low ASA score due to contamination from peritonitis, as van Walraven and Musselman[6] also suggested in their recent report. Our previous study, which might be the only such report, examined the efficacy of abdominal closure using PDS Plus on S-SSIs and demonstrated that the incidence of S-SSIs increased with urgent gastroenterologic surgery.[11] To the best of our knowledge, no reports have examined in detail the risk factors for SSIs after urgent gastroenterologic surgery. Thus, surgeons have not been informed of the measures that they can implement to reduce the risk of SSI development.

Therefore, the risk factors for S-SSIs after urgent gastroenterologic surgery were retrospectively examined, and the impact of abdominal closure using PDS Plus on the reduction of S-SSIs and the hospital stay after urgent gastroenterologic surgery was examined.

Patients and Methods

A total of 287 patients underwent unplanned, urgent gastroenterologic surgery at Fukuoka University Hospital in the 5 years between July 2008 and March 2014. Of the 287 patients, those whose records lacked clinical data were excluded. Finally, 275 patients were enrolled in the present study. A retrospective analysis was performed to investigate the correlation between the development of an S-SSI and factors from the patients' clinical data. Age; sex; body mass index (BMI); diabetes mellitus; smoking; administration of steroids; wound classification; ASA score; the presence or absence of peritonitis; the performance or nonperformance of laparoscopic surgery; operation time; blood loss volume; transfusion; and abdominal closure using PDS Plus were selected as the variables for the analyses.

Student's *t*-test was used for statistical analyses of the correlations between S-SSI development and age, BMI, operation time, blood loss, or transfusion. The χ^2 test was used for sex, smoking, and peritonitis, and Fisher's exact probability test was used for diabetes mellitus, steroid medication, and abdominal closure methods. Finally, the Mann-Whitney *U* test was used for wound classification and the ASA score. *P* values of less than 0.05 were considered significant.

In addition, a propensity score–matching analysis was performed to examine the utility of abdominal closure using PDS Plus in reducing the incidence of S-SSIs in cases of urgent gastroenterologic surgery. The propensity score was calculated using the following variables: age, sex, BMI, operation time, blood loss, and transfusion. After matching, 108 patients were paired, and the efficacy of abdominal closure using PDS Plus was analyzed by Fisher's exact probability test to determine its impact on the incidence of S-SSIs, while Student's *t*-test was used to determine its effect on the duration of hospital stay.

The present study was approved by Fukuoka University Hospital Clinical Research Assist Center on August 22, 2012 (No.12-7-06).

Table 1 The correlation between S-SSI and clinical characteristics

Characteristics	S-SSI (+)	S-SSI (–)	*P* value
Age	65.2 ± 17.0	58.5 ± 21.8	0.053[a]
Sex			
Male	23	131	0.59[b]
Female	21	100	
BMI	22.1 ± 3.8	21.0 ± 3.8	0.10[a]
DM			
(+)	5	23	0.79[c]
(–)	39	209	
Smoking			
(+)	13	52	0.31[b]
(–)	31	180	
Steroids			
(+)	4	8	0.11[c]
(–)	20	224	
Wound classification			
1	1	18	0.0005[d]
2	14	120	
3	18	70	
4	11	23	
ASA			
1	3	37	0.043[d]
2	14	81	
3	13	65	
4	11	45	
5	3	4	
Laparoscopic surgery			
(+)	0	11	0.22[c]
(–)	43	212	
Operation time, min	173.2 ± 100.7	127 ± 65.2	0.0001[a]
Blood loss, mL	365.8 ± 821.4	141.3 ± 521.2	0.019[a]
Transfusion	244.5 ± 744.8	69.0 ± 251.0	0.0047[a]
Abdominal closure			
PDS-Plus (+)	4	53	0.042[c]
PDS-Plus (–)	40	179	

[a]Student's t-test

[b]Chi-square test

[c]Fisher's exact probability test

[d]Mann-Whitney's U-test

Results

Of the total 275 patients who underwent urgent gastroenterologic surgery, 43 (15.6%) had S-SSIs. ASA score ($P = 0.043$) and wound classification ($P = 0.0005$) were significantly higher in patients with S-SSIs compared to without S-SSIs. In addition, peritonitis ($P = 0.019$); prolonged operation time ($P = 0.0001$); increased blood loss ($P = 0.019$); transfusion ($P = 0.0047$); and abdominal closure without triclosan-coated polydioxanone ($P = 0.042$) were identified as significant risk factors for the development of an S-SSI after urgent gastroenterologic surgery on univariate analyses (Table 1). However, multivariate analysis identified only wound classification ($P = 0.0072$) and prolonged operation time ($P = 0.011$) as significant independent risk factors for the increased incidence of S-SSIs (Table 2).

Table 2 The multivariate analysis of variables correlated with S-SSI

Characteristics	Odds ratio (95% confidence interval)	*P* value
Wound classification	0.374 (0.176–0.795)	0.011
ASA score	1.184 (0.548–2.558)	0.668
Operation time	1.007 (1.002–1.012)	0.004
Blood loss	1.000 (0.999–1.001)	0.459
Transfusion	1.001 (1.000–1.002)	0.181
Abdominal closure using PDS Plus	2.435 (0.793–7.478)	0.12

Table 3 Patient characteristics after propensity score matching

	PDS Plus	Control	*P* value
Age	53.9 ± 21.3	59.4 ± 22.9	0.21[a]
Sex, M/F	32/21	30/24	0.61[b]
BMI	21.5 ± 4.2	21.6 ± 3.5	0.90[a]
DM, +/–	3/51	4/50	0.99[c]
Smoking, +/–	14/40	10/44	0.49[c]
GI/HBP	51/3	52/2	0.99[c]
Wound classification, 12/34	38/16	40/14	0.67[b]
ASA score, 12/34	26/28	27/27	0.99[b]
Operation time, min	128.1 ± 63.7	123.3 ± 53.7	0.97[a]
Blood loss, mL	68.1 ± 183.3	70.2 ± 166.2	0.95[a]
Transfusion, +/–	4/50	2/52	0.68[c]

[a]Student's *t*-test.

[b]Chi-square test.

[c]Fisher's exact probability test.

The characteristics of the paired patients after propensity score matching are summarized in Table 3. There was no significant difference in the incidence of S-SSIs between the patients who underwent abdominal closure with or without PDS plus. Abdominal closure using PDS Plus did not reduce the incidence of S-SSIs ($P = 0.20$), but a nonsignificant association was found between abdominal closure using PDS Plus and a shorter duration of hospital stay ($P = 0.082$) (Table 4).

Table 4 Efficacy of PDS Plus after propensity score matching

	PDS-Plus	Control	*P* value
S-SSI, +/–	3/51	8/46	0.20[a]
Hospital stay, d	14.2 ± 12.2	19.7 ± 19.4	0.082[b]

[a]Fisher's exact probability test.

[b]Student's *t*-test.

Discussion

Although abdominal closure using PDS Plus has been reported to reduce the incidence of S-SSIs, the topic remains controversial.[7–10] The authors previously reported that closure of both the abdominal fascia and the skin using PDS Plus was effective for reducing the incidence of S-SSIs after gastroenterologic surgery.[11] In the present study, the efficacy of abdominal closure using PDS Plus for reducing the incidence of S-SSIs after urgent gastroenterologic surgery was analyzed retrospectively.

In the retrospective univariate analyses, abdominal closure using PDS Plus was associated with a reduced incidence of S-SSIs after urgent gastroenterologic surgery, as were a number of other factors, including ASA score, wound classification, peritonitis, prolonged operation time, increased blood loss, and transfusion. However, abdominal closure using PDS Plus alone was not an independent factor in the multivariate analysis. The result of multivariate analysis suggested that shortened operation time reduces S-SSI in the urgent gastroenterologic surgery the same as many previous reports. In addition, patients with high ASA score or wound classification commonly need the urgent surgery because of their disease characteristics, and it was inevitable that a parallel increase would be observed in their incidence of S-SSIs.[6] The previous report from our department suggested that abdominal fascia closure using Vicryl Plus (Ethicon) reduced the risk of SSI, but the efficacy was limited to patients with wound classification II.[13] Similar to those results, the efficacy of PDS Plus in urgent surgery was also limited, and its efficacy was less in urgent surgery, in which higher wound classification cases predominate. Recently, Yamamoto *et al*[14] reported the efficacy of the preventive SSI bundle in the patients with colorectal perforation. The bundle was composed of the use of PDS Plus, the irrigation with more than 500 mL of warm saline, no subcutaneous drain, and antibiotic administration within 30 minutes prior to surgery and every 3 hours. Thus, the present result might support that the bundle concept composed of saline irrigation, no drain, and antibiotic administration methods as mentioned above; but not single factor of PDS Plus usage was required for the prevention of S-SSI in urgent gastroenterologic surgery.

In contrast, it is of interest that abdominal closure using PDS Plus might shorten the duration of hospital stay regardless of the incidence of S-SSIs. This finding indicates that PDS Plus might inhibit bacterial activity and prevent prolongation of the infections. Several lines of evidence support this finding. Ming *et al*[15] reported on the antibacterial efficacy of PDS Plus, as determined by a zone of inhibition assay, and noted that it had activity against *Staphylococcus aureus,* methicillin-resistant *Staphylococcus*, *S. epidermidis*, methicillin-resistant *S. epidermidis*, *Klebsiella pneumoniae, and Escherichia coli*. In addition, in the present study, most of the urgent surgeries were performed for patients with appendicitis, perforation of the gastrointestinal tract, ileus, and cholecystitis. A few previous studies have reported the bacterial strains causing SSIs after urgent surgery. It was suggested that *E. coli* is mostly identified in incarcerated and/or strangulated hernias, and that 37.1% of fluid in the hernia sac and 33.3% in wound drainage contains *E. coli*.[16] Chen *et al*[17] reported that acute appendicitis cultures most frequently contained *E. coli* (85%); *K. pneumoniae* (26%); and *Streptococcus spp*. (25%), and that while it was not frequently identified, there was a correlation between *Pseudomonas aeruginosa* (15%) and the incidence of SSIs. Furthermore, *E. coli*, *K. pneumoniae*, and *Enterococcus spp*. have been frequently identified from cultures of bile and gallbladder wall in patients with acute cholecystitis.[18] Taking these SSI-causative bacterial strains and the bacterial-inhibiting effect of coated triclosan into consideration, abdominal closure by PDS Plus might be able to shorten the duration of hospital stay by inhibiting the bacterial activity and preventing the prolongation of S-SSIs after urgent gastroenterologic surgery, although it could not reduce the incidence of S-SSIs. Therefore, as the effort of individual surgeons might be one of the factors affecting the duration of hospital stay after urgent gastroenterologic surgery, closure of the abdominal fascia and skin by PDS Plus might decrease the patients' mental and economic burdens by shortening the hospital stay, even if it does not reduce the incidence of S-SSIs.

The present study has some limitations. The propensity score-matching analysis method is one kind of retrospective analysis; it was recently developed to eliminate statistical bias by distributing the patients' background characteristics as uniformly as possible. However, to eliminate statistical bias in this method, many cases are excluded, and a huge series might be required to ensure its statistical objectivity. In fact, 158 of 276 cases were excluded in order to match the patient scores, and only 108 (39.1%) cases were analyzed after matching. The operations that are performed during urgent surgery vary widely, and clinical data cannot easily be accumulated due to the various disease

characteristics of the patients. Thus, it might be difficult to distribute the background characteristics of the patients for the retrospective analysis. To overcome these limitations, a multi-institutional, prospective, randomized study using a large series of patients would be required, although it might be hard to plan practically. Otherwise, the accumulation of many reports such as the present one is required for a meta-analysis.

In conclusion, the present study suggests a clue for reducing the incidence of S-SSIs and shortening the hospital stay after urgent gastroenterologic surgery. The shortened operation time is a procedure that the surgeon can perform in an attempt to reduce the incidence of S-SSIs, and the closure of the abdominal fascia and skin using PDS Plus might be a procedure that the surgeon can perform in an attempt to shorten the hospital stay after urgent gastroenterologic surgery.

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